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Simulation of a photo-solar generator for an optimal output by a parabolic photovoltaic concentrator of Stirling engine type

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Abstract

Solar energy is the source of the most promising energy and the powerful one among renewable energies. Photovoltaic electricity (statement) is obtained by direct transformation of the sunlight into electricity, by means of cells statement.

Then, we study the operation of cells statement by the digital simulation with an aim of optimizing the output of the parabolic concentrator of Stirling engine type. The Greenius software makes it possible to carry out the digital simulation in 2D and 3D and to study the influence of the various parameters on the characteristic voltage under illumination of the cell.

The results obtained enabled us to determine the extrinsic factors which depend on the environment and the intrinsic factors which result from the properties of materials used.

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Keywords: photovoltaic cell, solar generator, simulation, optimization, concentrator photovoltaic, Stirling engine;

1. Introduction

The solar concentrator coupled to a Stirling engine is a new technology which makes it possible to transform solar energy into electric power. Solar energy is collected and concentrated thanks to a parabola of mirrors. This one starts a Stirling engine, this type of engine was invented in 1816 by Pasteur Robert Stirling. It is also called "engine with hot" or "external combustion engine air". The principal fluid is a gas, subjected to a thermodynamic cycle simple compound of 4 phases:

- an isochoric heating (with constant volume)
- an isothermal relaxation (at constant temperature)
- an isochoric cooling
- an isothermal compression

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The engine functions if it is fed by a thermal energy. This thermal energy can resulting either from external combustion from be derived from oil, natural gas, coal, or of renewable energies like the solar one or geothermics. The external combustion of this engine returns it less dirty , it is quiet, easy of maintenance and has the possibility of being reversible.



Example of engine of Stirling supplied with a solar concentrator

2. Results and discussions

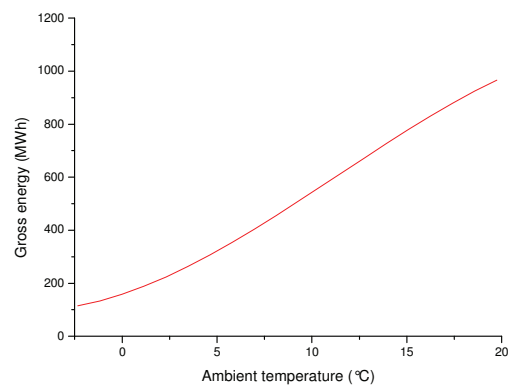


Figure 1: Variation of the gross energy according to the ambient temperature

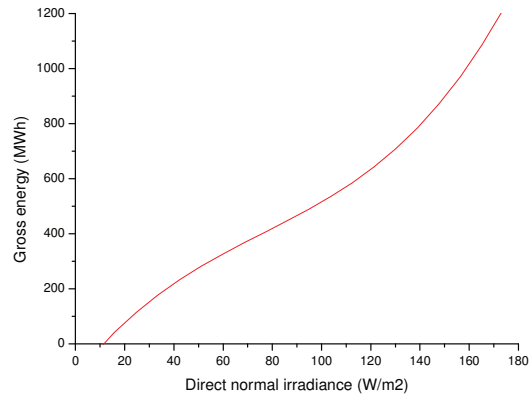


Figure 2: Variation of the gross energy according to the direct normal irradiance

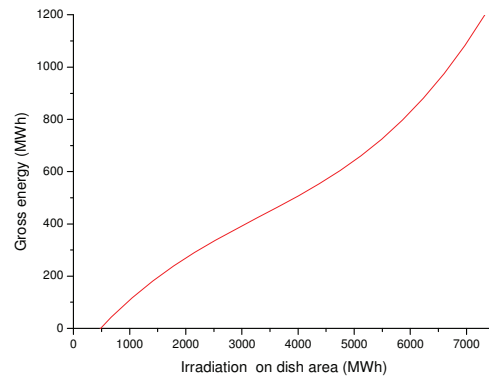


Figure 3: Variation of the gross energy according to the irradiation on dish area

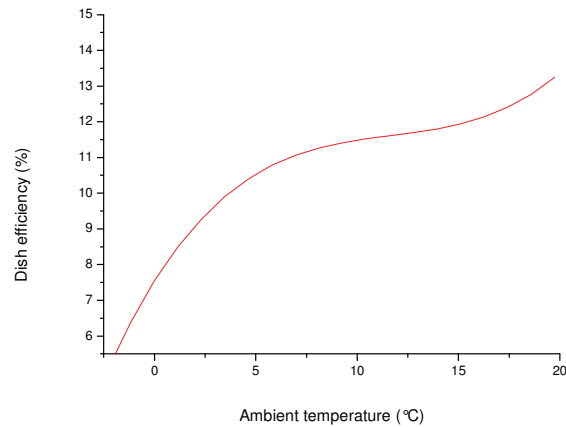


Figure 4: Variation of the dish efficiency according to the ambient temperature

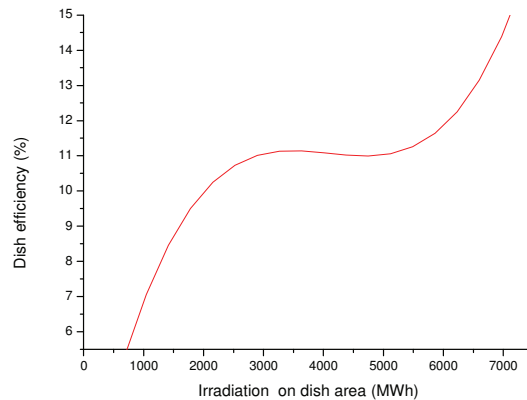


Figure 5: Variation of the dish efficiency according to the irradiation on dish area

In figures 1, 2 and 3 that the crude energy increases according to the ambient temperature of normal direct radiance and the parabolic surface of the photovoltaic concentrator, it reaches a maximum value of 1047.30 MWh.

In figures 4 and 5 that the dish efficiency increases according to the ambient temperature and by the parabolic surface of the photovoltaic concentrator, it reaches a maximum value of 13.91%.

Conclusion

Industrial side, the American company Stirling Energy Systems beat the record of effectiveness in conversion solar-electricity on January 31, 2008, reaching 31,25% The preceding record, going back to 1984 was 29,4%

This system is particularly interesting in zones where the sunning is mainly made up of direct radiation, i.e. in the intertropical zones.

Advantages

- Performances:** the output is generally of the same order as for panels photovoltaic, but this type of system reached outputs higher than 30% in the conversion of the solar radiation into electricity
- Simplicity:** the principle of operation is relatively simple, vis-a-vis photovoltaic technology, and makes it possible to manufacture oneself a solar concentrating system Stirling engine (with outputs not inevitably interesting however)
- Cogeneration:** the Stirling engine can function in cogeneration (valorization of work AND heat available) leading to a very good total output
- Range of power:** possibility of adapting the power to the need following the hot source used (of MW with MW)
- Isolated sites:** like the whole of renewable energies, the Stirling system with solar concentration allows the electrification of sites isolated without requiring the connection with the distribution network of electricity.

Projects of power stations equipped with several thousands of Stirling parabolas are under development in the world. An American company recently inaugurated Nevada Solar One, an installation of 64-megawatt coutant nearly 250 million Dollars.

The companies in the course of launching of production of this system announce launching into 2009 of complete installations with converter of electricity, which should be able to compete with the photovoltaic panels. However, the Stirling engine is still dear bus it does not have there for the moment not applications which require a manufacture on a large scale.

One can think that the cost of these installations will drop in the years to come, which should make advantageous autonomy, the low maintenance costs and the weak environmental impact which these machines propose.

Disadvantages

- Cost:** the Stirling engine being developed still little, it is a very expensive material
- Sealing:** if the pressure of operation is high, it is difficult to contain gas used in the engine. This problem is all the more complicated as one gas very interesting for the Stirling engine is the hydrogen (for its lightness and its significant heat-storage capacity), which diffuses easily through materials
- Volume:** the heat transfers with gases generally require great volumes
- Modulation:** a Stirling engine functions very well with nominal nominal output, but of the fast variations of power are difficult to realize, and the effectiveness can quickly fall
- Intermittency:** this system being fed by the sun, it knows a production subjected to the weather risks. To mitigate this discontinuity, an auxiliary system or a system of storage can be set up to ensure the autonomy of this type of device.

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